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ABSTRACT

The objective of the Easy Math Program is to give all students (not just those with mathematical talent) an intuitive grasp of the quantitative principles on which mathematics is based, so they will be able to execute its basic operations with insight, and move on to its higher concepts with confidence. The program approaches this objective by a blend of carefully sequenced activities. These activities, which begin at an elementary level, have been developed to eliminate the most common errors children make when doing seatwork mathematics. New concepts and skills are always introduced in the context of concrete, manipulative experiences. In addition, the activities provide a great deal of support for the gradual transfer of insights which children acquire in the context of their object manipulation to the world of numerals and symbols. Provided in this teaching guide are the aims, list of special materials needed, instructional strategies, related activities, and game information for activities in seven student booklets. Topic areas of booklets include: counting to 10; addition and subtraction (under 10); tens and units; early multiplication/division; beginning money skills; telling time; and equivalents/fractions. A separate section on use of games and game boards is also included. (JN)

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Foreword

In the past two and a half decades there has been a virtual explosion of research in the fields of cognitive and developmental psychology. For those of us who have been involved in this endeavor, it has been a heady time. Inspired by theorists such as Piaget, Bruner, and Chomsky, and by recent advances in the field of cognitive science, we have come to understand the stages in the child's intellectual odyssey in far greater detail than we have ever dreamed possible. We have also come to glimpse something of the process by which children propel themselves from one of these stages to the next, and the obstacles which they must overcome en route.

During the same time period, and inspired by the same cognitive revolution, research on children's classroom learning has also entered a new phase. As the conceptual tools for understanding children's behavior have become more sophisticated, researchers have come to understand the problems and processes of classroom learning at a far deeper level. This has been accompanied by a refinement of existing instructional techniques, and a flowering of new ones: a renaissance which would have been unimaginable twenty-five years ago.

At the confluence of these two streams of research, an interesting teaching method has arisen. Combining the insights from the field of development with those from the field of learning, this method might best be labelled "developmentally based instruction." The method begins with a microanalysis of the developmental levels through which children normally progress, en route to mastering a particular intellectual skill. It then matches children's learning experience to their current developmental level, and provides them with a set of carefully designed auxiliary aids so that they can make the transition to the next level in a smooth fashion: without straining or overloading their cognitive system. Although research on this method is still in its infancy, it has shown great promise, both in psychological laboratories and in experimental classrooms.

The author of the Easy Math Program — and its companion program, Bridge Reading — is one of the pioneers of this developmental method. With the publication of her two programs, therefore, an important step is being taken. The developmental method is being moved out of its purely experimental phase into a phase where it can be scrutinized and utilized by educational practitioners in the field. For those of us who have assisted at the birth of the method or played a role in articulating its basic principles, this is an extremely exciting moment; for we believe that the method has the potential to achieve a vital social purpose.

In the case of the Easy Math Program, this purpose is quite simple. It is to bring the world of mathematics within the grasp of all school children, even those who would otherwise be denied access to it because they have some special handicap, or because they are functioning at too low a level of cognitive development, or simply because they have "no head for math." The objective of the program is to give *all* students — not just those with mathematical talent — an intuitive grasp of the quantitative principles on which mathematics is based, so that they will be able to execute its basic operations with insight, and move on to its higher concepts with confidence.

The program approaches this objective by a blend of carefully sequenced activities, each of which appears quite conventional by itself, but which are quite revolutionary

in combination. Four particular features of these activities are worthy of note. The first is that the activities begin at a very elementary level. The initial exercises are designed to teach matching and counting skills which a great many first-grade students possess already, but which can constitute a major stumbling block for those who do not. Talented students will of course complete these exercises very quickly. For the less talented, they will take longer, but will form an invaluable base from which their entry into the world of arithmetic can then be launched.

The second noteworthy feature of the activities is the form of explanation which they provide for any concept or operation which is new. New concepts and skills are always introduced in the context of concrete manipulative activities, in which both the meaning and the results of any operation are intuitively obvious. Nowhere is the value of this more apparent than with the concepts which have traditionally given students the greatest difficulty, namely, the base-ten system, zero, and fractions.

The third noteworthy feature of the activities is that they provide a great deal of support for the gradual transfer of the insights which children acquire in the context of their object manipulation to the world of numerals and symbols. A number of programs – even those that are manipulatively based – have fallen down at this point in the past, with the result that students have developed one set of rules for the "real" world of objects and number blocks, and another for the "foreign" world of numerals and symbols. A major role in avoiding these problems is played by the games which accompany most sections of the Activity Books. These games provide children with a great deal of practice in going from one world to the other and back, with the result that the two worlds in fact become one, and the answers to symbolically stated problems can be given in a direct, intuitive fashion.

The fourth and final noteworthy feature of the activities is that they have been developed with an eye to eliminating the most common errors that children make when doing seatwork in math. The steps which have been taken to circumvent these errors are ingenious, and include the provision of temporary perceptual crutches, as well as the inclusion of a variety of devices for reducing the child's information processing load. As a result of these various techniques, then, the expectation is that all children will move through the program in a relatively error-free fashion, and that – as they do so – they will develop a growing sense of insight, mastery, and confidence.

The author of the Easy Math Program must not be allowed to remain anonymous behind the curriculum which she has created. Alison Dewsbury is a distinguished Australian educator, who has devoted the most productive years of her professional life to working with school-aged children, and who has travelled the globe in an effort to ensure that the educational programs she has designed will be suitable for children from the widest variety of cultures. She is a passionate and a caring individual: one with a deep faith in the intellectual potential which lies within all children – regardless of their age and regardless of their particular cognitive or perceptual handicaps. She is also a person with deep respect for each child's individuality. In making presentations on her work, she is rarely to be heard discussing the psychological profiles of the children who have learned mathematics by her method – although these are impressively varied. Nor is she to be heard discussing the rate of success which she has achieved – although this also is impressive. Rather, she is to be heard talking about "her Timmy," her "Tania," or her "David," and displaying the worksheets they have completed. As she does so, she radiates a sense of enthusiasm and pride, not in her own achievement, but in theirs.

She has earned that right. For Mrs. Dewsbury has gone where those of us who have spent our lives in the psychological laboratory have rarely been able. She has entered not only the minds, but the hearts and lives of her pupils. And, in so doing, she has earned their undying gratitude and affection.

Those of us who have had the opportunity to work with Mrs. Dewsbury at OISE are also grateful for the chance we have had to interact with her and to study her programs. And we are both delighted and proud to be associated with their publication.

Robbie Case
Center for Applied Cognitive Science
OISE

Easy Math — An Overview

Consists of:

1. Teacher's Guide
2. Treasure Hunt Cards (in Games Kit) — comprising Sections 1 and 4.
3. Activity Books:
   1. Counting to Ten — Sections 2-10.
   2. Addition to Ten — Sections 11-18.
      Subtraction Below Ten — Sections 19-21.
      Changing Concepts — Section 22.
   3. Tens and Units — Section 23.
      Addition with Tens and Ones — Section 24.
      Addition with Regrouping to 100 — Section 25.
      Subtraction with Regrouping Below 100 — Section 26.
      Changing Concepts — Section 27.
   4. Early Multiplication — Sections 28-30.
      Early Division — Sections 31-32.
   5. Beginning Money Skills — Sections 33-34.
   6. Time Telling — Sections 35-39.
   7. Equivalence — Section 40.
      Fractions: fractional number — Sections 41-44.
      simple addition — Section 45.
      simple subtraction — Section 46.
4. Games:
   1. Counting game
   2. Race Track games (a) for counting consolidation
      (b) for automatization of learned skills
   3. Tens and Units (tens and ones) games

Aim Understanding, Success, Independence } at each level

1. The system is based on the isolation of each skill. The skills are broken down into their component parts. They are then rebuilt, using extremely small sequential steps.
2. The child progresses steadily through each skill level, moving from one to the next when competency is achieved. Self-correction is indicative of fundamental understanding.
3. Open-ended games lock into the skill levels and provide essential over-learning.
4. No written instructions are given for the students. Each section starts with an "instructional" page which shows the child what is expected.

5. Numerals are large and clear.
6. Large spaces are provided for child response.
7. Numerals are always presented in correct sequential runs.
8. A faint grey strip is used to help the child to overcome difficulties with orientation in space.
9. Color is used to aid differentiation between numerals in early computation.
10. A color cue is used to help the child change from one concept to another.
11. A color cue is also used to help the child gain an understanding of tens and units (tens and ones).
12. Children develop an understanding of numbers after ten and of place value through games.
13. When a "crutch" is removed, the level of difficulty is lowered to ensure continuing success.
14. Skills are taught in the environmental context initially. They are then gradually applied using concrete aids until abstraction is achieved.

Note: (a) Counters and other concrete aids should be available to all children as required. Each child will discard them when ready.

(b) All the race track games are open-ended and can be played by different children using their own packs of cards.

(c) GAMES ARE DESIGNED TO ACHIEVE AN INSTANTANEOUS RESPONSE THROUGH MOTIVATING PRACTICE. They remove the need for dull drill by providing sufficient repetition in a stimulating situation. They should be played at the independent level of functioning. They are NOT provided to keep children busy, or as a reward, or to give the teacher time to concentrate on individuals; they may serve any or all of these functions, but their chief purpose is to provide over-learning.

(d) Printed numerals from the numeral card (3) may be placed in the "answer box" by the child who cannot print. Printing may then be taught as a parallel skill which may take much longer to acquire.

(e) Numerals on the numeral card (3) are printed according to the format generally used in early childhood education.
Numerals in the activity booklets are printed according to common environmental usage.
It has been found that this dual use of numerals is beneficial to young children, as it brings about generalization. The children learn to read the commonly used type, but to print the easier format.
Initially (Section 1), the children deal only with the "school" numerals. When they are introduced to the activity books, it is necessary to show them that the two forms of 4 and 9 "say the same thing". This does not appear to cause any difficulty.

Games

Components

- Four race track boards (space race, car race, animal race, plane race).
- Thirty-one games cards (two-sided), which cut up into packs of cards. The packs of cards are used with the race games.
- A nine- and six-space spinner card (one-sided).
- Two tens and units board games (fishing game and pirate ships game).
- Two perforated sheets of animal, car, plane, space, fish, and ship figures.
- You will need to get Unifix cubes or "ten" and "one" Diennes blocks.

1. COUNTING GAMES

1. "Count the spots"
2. Race Track games

AIM: To consolidate (1) one-to-one correspondence
(2) numeral recognition
(3) counting to ten

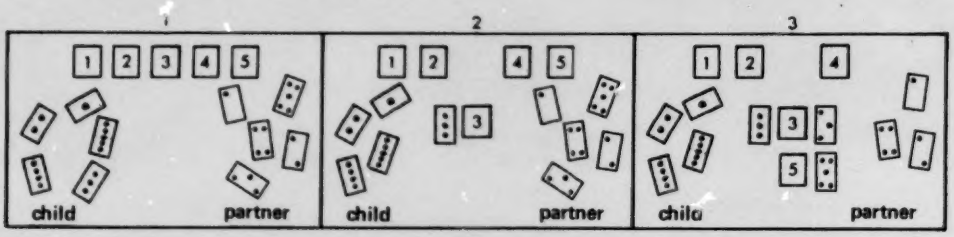
ALL COUNTING GAMES SHOULD BE SUPERVISED TO ENSURE CORRECT RESPONSES.
DO NOT USE DICE, NUMERAL, OR SPOT CARDS BEYOND THE LEVEL OF UNDERSTANDING.

Game 1: "Count the spots"

Two players.
Use game cards 1, 2, and 3 to level of competency.
Procedure:
Child spreads out yellow cards.
Partner spreads out blue cards.
Numeral cards placed in sequential order (see illustration 1).

Child:
(1) chooses yellow card
(2) counts spots using finger
(3) turns card over, looks at numeral, says, "This says (three)"
(4) matches numeral with numeral card in line
(5) places both cards in space between players (see illustration 2)

Partner:
(1) finds card from blue set with same number of spots
(2) places beside child's cards in centre space
(3) chooses another blue card
(4) proceeds as in (2) to (5) above (see illustration 3)



Game 2: Race Game

Use any of the four race track boards (space race, car race, animal race, plane race).
Initially use games card 1 (spots placed in line).
Then progress to games card 2 (spots placed in arrays).
Two to four players.
Children choose preferred figure from perforated sheet and place in starting position.

First child:
(1) picks up top card from pack
(2) counts spots
(3) turns card over, saying, "This says (two)"
(4) moves figure (two) places
(5) places used card at bottom of pack

Second, third, and fourth child repeat sequence.
The first past the end of the track wins.

Teaching the Strategies for Playing Board Games

Do not forget that some children will have to be introduced to the strategies of using a games board before they can play effectively. Some of these strategies are:

(1) Placing figures in starting position.
(2) Turn taking.
(3) Forward progression along the track. One of the most difficult things for a young child to learn is that when you move your figure, "one" is the space in front of you and not the space you are already in.
(4) What to do when you overtake the other person, namely, count the space the other person's figure is in, do not just jump over it!
(5) One number to one space – an extension of one-to-one correspondence. Many children have to have their hand guided, as they make definite and discrete jumps from space to space, saying the numbers.
(6) What to do if you land on the same space as another – you share the space together.
(7) What to do at the end. It is suggested that the winner is the one who "goes over the end first," regardless of what has been thrown.

2. ADDITIONAL SKILLS

Addition, subtraction, multiplication, division, time, money, and fractions.

AIM: (1) To provide as much practice as each child individually requires to make the procedures automatic.
(2) To obtain an instantaneous response to number facts in motivating circumstances.

CHILDREN MAY PLAY INDEPENDENTLY ONCE THE RULES ARE LEARNED.

Use any race track board. Two to four children may play.
Use pack of cards chosen from games cards 4 to 31, according to children's level of functioning.
Use six-space spinner or dice, if preferred.
Let children choose preferred figure from perforated sheets.

Procedure:

First child:
(1) spins (or throws dice) and moves appropriately
(2) picks up top card from pack, for example, Addition, 3 + 2
(3) says answer – "five" – having used concrete aids, if necessary
(4) turns card over to check answer
(5) if correct, moves forward three places as a reward
(6) if incorrect, uses concrete aids to obtain right answer, and moves forward three places for getting it right

The used card is placed at the bottom of the pack.

Multiplication Tables

Initially use only three cards.
Add to these when they are learned.
Child simultaneously says computation and LOOKS AT ANSWER.
Child repeats computation and answer twice out loud.
Child moves forward three places.

NOTE: The child is ALWAYS rewarded for getting the right answer by moving forward three places. If the answer is wrong, it is ALWAYS put right.

3. TENS, UNITS, AND PLACE VALUE

PLAY THE FOLLOWING GAMES AS SOON AS THE CHILD CAN COUNT TO TEN:

(1) Fishing Game
(2) Pirate Ships Game

AIM: (1) To enable the children to understand tens and units.
(2) To relate this to place value, preventing reversals.

Procedure:

Two to four children may play.
Place unifix cubes in piles of "tens" adjacent to games board.

and "ones"

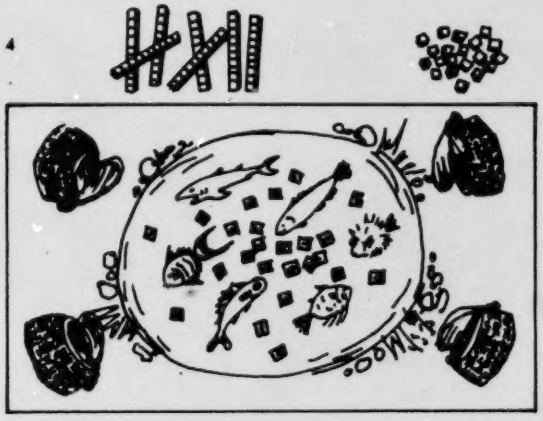
Place all the fish or all the ships in the centre of the board (see illustration 4).

(1) First child spins (or throws dice) and picks up appropriate number of "ones."
(2) First child puts "ones" in home-base on board (fishing basket or beach). Second, third, fourth child follow suit.
(3) First child spins again. Child picks up appropriate number of "ones" and places them with the others in the home-base.
(4) Child then counts the total number of "ones", stopping if ten is reached. If it is, then . . .
(5) The ten "ones" are exchanged for a "lot of ten."
(6) The "lot of ten" becomes a fishing rod or a cannon, and a fish or ship is captured and kept by the child.
(7) Child then says, "I have one lot of ten and two ones."

The game can finish whenever convenient. The winner is the child with the greatest number of tens and ones.

Scoring: Initially, the child does not record a score on paper, but reports verbally:
(throws three) "I have three ones"
(throws four) "I have seven ones"
(throws five) "I have one lot of ten and two ones"
(throws seven) "I have one lot of ten and nine ones"
(throws five) "I have two lots of ten and four ones"
etc.
As soon as the children can play the game confidently without having to think about the rules, teach them how to record their score on paper (see illustration 5).

4



5

	3	throw 3
	7	throw 4
1	2	throw 5
1	9	throw 7
2	4	throw 5
3	0	throw 6
3	5	throw 5
		etc.

Extension of Games Boards

A high degree of motivation and interest will be maintained if many different games boards are available to the children.

These may be produced very quickly and with little effort if gift wrapping paper is used.

Choose wrapping paper illustrating topics of high interest such as cars, animals, skating, cartoon characters, and so on.

Draw either a race track or four home-bases on the wrapping paper with a thick, black marker pen.

Laminate or cover to preserve the board.

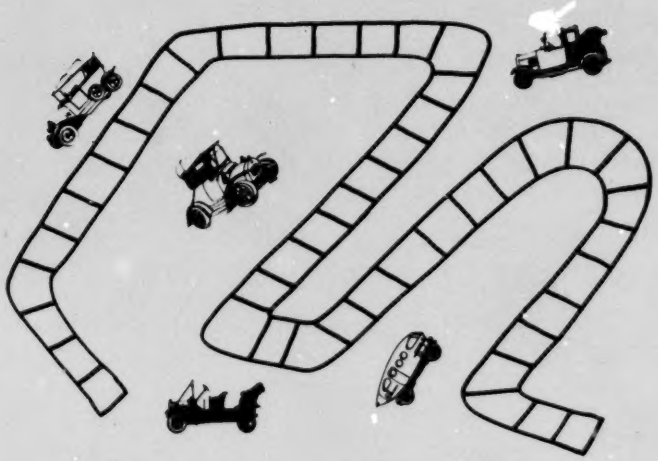
If possible, use "real" objects, like plastic animals, little cars, or trinkets out of crackers or off key rings instead of discs or counters.

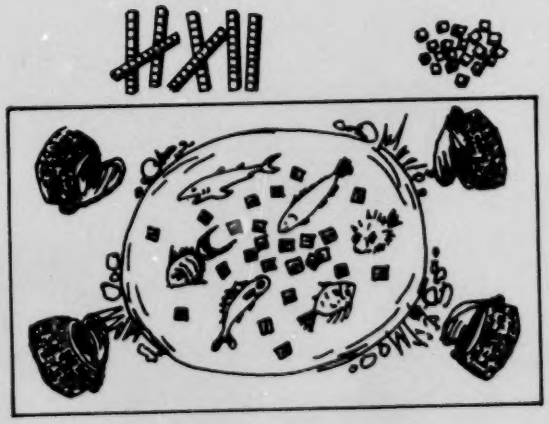
For the Tens and Units (tens and one) game, the objects in the middle of the board may be obtained by purchasing an extra sheet of the appropriate gift paper, covering it, and then cutting out the pictures.

Little imagination is needed to invent a topic which the children will enjoy! The race games are self-evident; examples of the Tens and Units games are:

- If using horse paper, have a pony round-up. The home-bases are corrals and the lot of ten a lasso.
- If using space paper, the home-bases are space stations and the lot of ten a ray gun.
- If using wild animal paper, the home-base is a cage, the lot of ten a tranquilizer dart, and you are having a safari.
- If using car paper, you can have a car auction and the lot of ten is the auctioneer's hammer.
- If using animal paper, the lot of ten can be a lottery ticket for a pet.

As you can see, the variety is endless. Most shops only have one or two suitable pieces, so get into the habit of scanning the racks! Illustrations 6 and 7 show you how easy it is!





Number and Numeration

Prerequisite Learning

It is vital that before children are presented with a concept in a two-dimensional form — as they are when given an activity book — they be given a great deal of experience of that concept through interaction with as many different concrete materials as possible.

In the ideal situation this interaction should take place within the natural environment of the children. Although the class teacher cannot be present at a child's home, yet it may be possible to keep in touch with the parent(s) so that the parent can reinforce and consolidate the learning that is taking place at school.

Some school situations permit outings and excursions, and these can form an ideal setting for initiation or expansion of concept learning. If this opportunity is unavailable, then it is suggested that playground duty provides the teacher with an excellent setting for the practical application of concepts.

The classroom itself should be used extensively for incidental concept learning The children can be taught through bodily involvement and through interaction with favorite play things.

The first section of *Easy Math*, the Treasure Hunt cards, indicates in a small way how this interaction may be achieved. This section is not intended to be all-embracing, but rather to point the way to many other activities.

It is, therefore, suggested that within their own settings, teacher and children should use their environment to the full:

- count the trees
- count stones
- count fence posts
- count paving stones
- count dustbins
- count each other (PROVIDED THAT ALL ARE STATIONARY)
- count doors
- count desks or tables
- count hooks for coats
- count lunch boxes
- count pencils/rulers/books/erasers . . .
- count and sing
- count and clap

COUNT COUNT COUNT
COUNT EVERYTHING

Activity Book 1 — Counting to Ten

Section One: Treasure Hunt Cards 1-10 (these are in the Games Kit)

Aim

1. To develop one-to-one correspondence.
2. To relate an appropriate numeral to a specific number of objects.

Children can often recite a number string without being able to allocate numbers to sequences of objects or pictures. They usually know, however, that one child sits in one chair and that one foot goes in one shoe and the other in the other shoe. These previously learned skills can be harnessed and integrated in this "Treasure Hunt," which bridges the gap between children's knowledge of the physical world and the "academic" knowledge of number, starting with the essential concept of one-to-one correspondence. Don't worry if the children are not yet able to recite a number string; they will learn through counting songs, games, the television, and in conjunction with the Treasure Hunt itself!

Special Materials

- Shoes, books, scissors, blocks, paint brushes, wax crayons, buttons, popsicle sticks, farm animals (plastic!), pencils.
- Make sure that there is at least one more than the number required on the Treasure Hunt card.
- Printed numerals (cut out from Games Card 3).
- Photocopy the cards as much as you like!

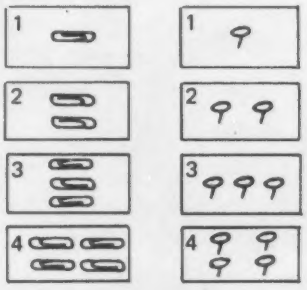
Note: It is easy to produce more cards in order to consolidate learning through the provision of additional cards.
Either (a) draw cards with different objects at each level; or
(b) place on a photocopier

(i) one (paper clip, or peg, or puzzle piece)

(ii) two (paper clips .....)

(iii) three (paper clips .....)

(iv) .....
and so on.



You will get an excellent image.

Procedure

Stage One:

Tell the child, "We are going to have a treasure hunt."

Give the child the first work card.

Let the child place one shoe on top of the pictured shoe.

If the child knows the number, let the child say aloud, "one shoe."

The child will repeat the activity with all pictured articles to card 10. Make parallels of cards 1 to 10 as required for further practice if needed. Photocopy or draw common classroom objects.

Stage Two:

Tell the child, "Now you will be very clever, you will have a treasure hunt, and you will choose the right number as well as find the treasures."

Give the child numeral cards 1 to 5.

Let the child place the concrete objects on top of the pictured objects, saying, "two books."

Let the child point to the printed numeral on the work card, saying, "this says two."

Let the child select the numeral card "2" and place it on top of the printed numeral.

Extend this to ten after the child is able to perform the activity competently to five.

Related Activities

Counting activities should be incorporated into all aspects of classroom and playground life. Counting should always take place slowly and the children should be enabled to touch each object as it is counted, moving from left to right. Initially, counting should always take place with an adult, in order to ensure correct responses and to remove the possibility of an incorrect response. Children should only be permitted to count independently as far as they can do so accurately. Large, stationary objects should be counted with a hundred percent success before any attempt is made to count smaller, mobile objects or small pictures, as lack of fine motor control, poor co-ordination, or inadequate physical organization might lead to error which is not, in fact, related to counting ability.

Number songs should be sung daily. It is suggested that as the children sing the number, they should clap or perform some appropriate action. This incorporation of a motor response to verbalization will reinforce the understanding of one-to-one correspondence. Number games involving the whole child should be played. The children may step/jump into discs on the floor marked "1 2 3 . . ."

The children may throw bean bags into hoops marked "1 2 3 . . .", verbalizing the number as they do so. It is suggested that the children do not count each other, as children rarely remain still and this leads to confusion and incorrect responses.

Games

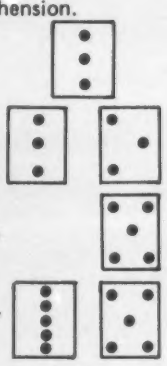
Play the game "Count the spots" (also see instructions on page 3).
Remove cards from pack which are beyond level of child's comprehension.

A. Play with matching sets cards alone:
Child with yellow cards selects card at random and places it on floor, having counted spots.

Child with blue cards selects matching set card from his pack, checks by counting, and places it beside yellow one on floor.

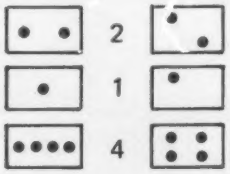
Child with blue cards now selects card from his set at random, counts, and places on floor.

Child with yellow cards finds matching set card from his pack, counts, and places on floor.



Procedure repeated.

B. Play with matching set cards and with numerals 1 to 10 (or with sets and numerals to mastery level).
Children play as before, but also take turns to select appropriate numeral to place between matching sets; for example,



Section Two: Pages 1-8 – Joining Picture to Numeral

Aim **To consolidate one-to-one correspondence and to order numerals by relating a sequence of pictures to appropriate numerals.**

Each page has a central grey strip. This is designed to facilitate the children's orientation on the page.

The first page of this and every subsequent section indicates to the children what is required by providing dotted lines to be traced over.

Procedure

1. Show the children the first page.
2. Say, "All the things in the white strip belong together." Accompany this statement with sweeping movement of fingers over the top white strip, which embraces both pictures and numerals. Say, "All the things in the grey strip belong together." Accompany this statement with a similar gesture embracing pictures and numerals which lie within the grey strip. IT IS EXTREMELY IMPORTANT THAT THE CHILDREN GRASP THE SIGNIFICANCE OF THE STRIPS AT THIS STAGE, AS THIS IS A PERCEPTUAL CRUTCH WHICH WILL AID THE CHILDREN'S PERCEPTION IN SPACE AND HELP TO FOCUS THEIR ATTENTION FOR MANY SECTIONS TO COME. The children are thus set free from a potential perceptual problem and enabled to focus without distraction on the skill which they are acquiring.
3. Show the children how to trace over the dots joining picture to numeral, saying "one" with the downward stroke. Similarly, say "one-two" with the two downward strokes. Repeat downward strokes with "one-two-three," turn the page and say, "Now let me see you do it all by yourselves."

Related Activities

Number and counting songs, games, and activities as before.

Games

Continue to play "Count the spots."

Section Three: Pages 9-13 – Count and Circle the Numeral

Aim **To count pictures and identify and circle the correct numeral.**

The children no longer have the crutch of joining the picture to the numeral to arrive at the correct number, but must equate the two independently. Some children may still have problems with the identification of specific numerals. If so, they can be taught the strategy of first counting the pictures, then counting along the numerals until they arrive at the same number, which they can then circle. Numerals are always presented in sequential runs beginning at one.

Procedure

Show the children the page. Repeat instruction about strips.

Let them count the cars.

Say, "How many cars?"

When the response "one" is given, say, "Which number says one?"

Children point to numeral "1" and then circle it, tracing over dots.

Repeat with two subsequent strips.

Turn to next page saying, "Now show me if you can do it by yourselves."

If the children can count the pictures, but cannot identify the correct numeral, show how to "count along" the numerals until the correct one is reached. This is, in effect, a primitive number line.

Section Three: Pages 14-17

Aim

1. **To respond to a different orientation, in order not to become directionally fixed.**
2. **To progress from the counting of ordered lines to the counting of an array.**

Counting Arrays

It is a big step for children to move from counting objects in an ordered line to counting an array of objects.

- Tip several objects or counters onto the table.
- Let the children look at them as they are, then arrange them in a straight line for counting.
- Show that it is easier to count things in a line than scattered.
- Tell the children they are clever when they arrange things in a line before they start to count.
- Explain that sometimes we cannot put things straight, because they may be stuck or in a picture.
- Show that you have to look at an array and "get it into lines in your head," either counting across or down, so that you don't count the same thing twice. Give much practice with different arrays.

Pages 15-16

Aim

1. **To continue to develop the organizational strategies necessary for counting arrays.**
2. **To select the correct numeral from an ordered sequence which no longer starts at 1.**

Recognizing a Numeral from a Sequence which Does not Start with 1

At this stage many children are able to recognize numerals quite easily. These children will experience no difficulty in circling the correct numeral on these pages and may not even notice that the sequences have different starting points. In the early stages of counting, however, it is still helpful to keep numerals in ordered sequential runs. Presenting the beginning child with numerals out of sequence can be most confusing if consolidation of ordering is still taking place. If numeral recognition has progressed beyond the stage when this matters, then this sort of exercise is redundant and the child should be working at the next stage.

There may be some children who still have difficulty in recognizing all numerals. These children may have learned the strategy of "counting along" the ordered sequence of numerals from 1, until they reach the required numeral. These children may still need the support of this strategy. If they do, give them their own special number line, starting from 1 not 0, and let them continue to count along it as a crutch (see number line below). This is one step removed from seeing the numbers on the actual page below the objects. Allowing the child to use this crutch will be the quickest way to teach numeral recognition, while not holding the child back from continuing progress. When the crutch is no longer needed, the child will not both to use it and it will be spontaneously discarded.

Page 17

Aim **To recognize and understand the concept of zero.**

The Concept of Zero

The easiest way to teach this is the teacher's time-honored method of acting it out:

"How many pencils do I have?" – "Two"

"How many pencils do I have now?" – "Four"

"And how many do I have *now*?" – "None!"

"Right! That's called ZERO!" And so on.

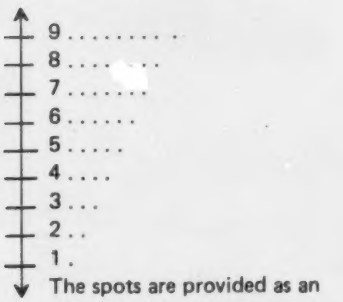
Move from the concrete to the two-dimensional page, giving the children a great deal of practice.

Note on Number Line

It can be a very good idea to give a child a *vertical* number line rather than a horizontal one. The reason is illustrated below.

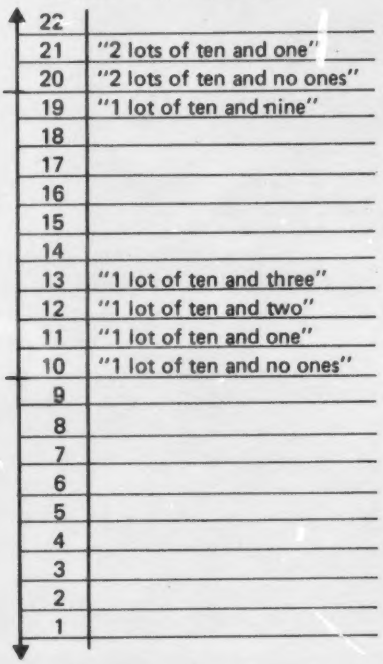
A vertical number line can provide one logical and sound illustration in two dimensions of the concept of tens and units and place value. (This concept will be firmly established through the playing of the Tens and Units game later on, when the child is constantly moving from the concrete to the abstract.) The vertical number line will reinforce this learning at the two-dimensional level. Although the concept of ten is not introduced on the first number line, it can be seen that there is a smooth flow into the second stage of learning this concept.

Number Line – 1st stage

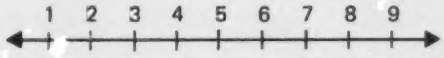


The spots are provided as an additional checking device for the child.

Number Line – 2nd stage



A number line may be introduced on the blackboard and used for reference and in games.



When children are thoroughly familiar with the "class" number line, individual number lines may be given to children. This will help the generalization process and provide children with an aid which is two, rather than three, dimensional.

Games

1. Continue to play "Count the spots".
2. Introduce the race track games with the counting cards.
   Start with pack 1 to the appropriate number, then progress to pack 2 when the children are learning to count arrays (See page 4 for how to play the game.)
   Do not forget that some children will have to be introduced to the strategies of using a games board before they can play effectively. Some of these strategies are:
   (1) Placing figures in starting position.
   (2) Turn taking.
   (3) Forward progression along the track. One of the most difficult things for a young child to learn is that when you move your figure, "one" is the space in front of you and not the space you are already in.
   (4) What to do when you overtake the other person, namely, count the space the other person's figure is in, do not just jump over it!
   (5) One number to one space – an extension of one-to-one correspondence. Many children have to have their hand guided, as they make definite and discrete jumps from space to space, saying the numbers.
   (6) What to do if you land on the same space as another – you share the space together.
   (7) What to do at the end. It is suggested that the winner is the one who "goes over the end first," regardless of what has been thrown.

Related Activities

1. Continue practice counting in real-life environmental situations.
2. Continue to sing and play action number songs.
3. *It is essential that oral counting be carried out daily.*
   A most effective method of doing this is as follows:
   (1) "We will all count and clap from one to ten – ONE, TWO, THREE . . ."
   (2) "We will all count to five, and then you will go on counting by yourselves to ten":
   Teacher and children: "ONE, TWO, THREE, FOUR, FIVE"
   Children alone: "SIX, SEVEN, EIGHT, NINE, TEN."
   (3) "We will all count to three, and then you will count to seven and stop":
   Teacher and children: "ONE, TWO, THREE"
   Children alone: "FOUR, FIVE, SIX, SEVEN."
   (4) Repeat as above with infinite variations with individual children, allowing each child to function according to level of ability.

Section Four: Treasure Hunt Cards 1-10 (second set)

(these are in the Games Kit)

Aim

To respond correctly to any given numeral from 1 to 10 by gathering together the correct number of objects.

Special Materials

Shoes, books, scissors, blocks, paint brushes, wax crayons, buttons, popsicle sticks, farm animals, pennies.

Procedure

Shuffle the cards so that they are presented out of numerical sequence.

The child reads the numeral and finds the requisite number of objects similar to the picture.

Further practice can be given by providing "clues" which relate to other classroom objects (chalk, rulers, erasers, and so on).

If the children get a hundred percent correct, they do not need to do any more. If several are wrong, revert to giving the cards in numerical sequence.

If only one is wrong, make sure that extra work is given at that level, but give other numbers as well to make sure the one in question can be differentiated.

Section Five: Pages 18-23 — Motor Response to a Numeral

Aim

To make an accurate motor response when specific numerals are presented.

The purpose is NOT to give practice in coloring or staying within the line; any mark or scribble is acceptable. The aim is to respond correctly to a numeral.

In the first part of this section, the children are required to color or mark a specific number of geometric shapes. These shapes have been deliberately chosen because they do not present a distraction to the children as would pictures of animals or other objects.

A subsidiary aim is to teach the children to check their own work.

Procedure

Show the children the page.

Replicate it on the blackboard and demonstrate, saying:

"This means color one shape" — do it!

"This means color two shapes" — do it!

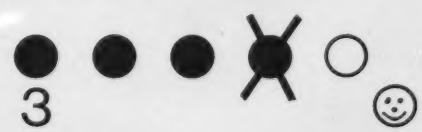
"Now you can show me how you do the last one."

Children may continue independently.

(Numerals continue in sequence until page 21, after which they are presented at random.)

Note: Teach the children to count the shapes they have colored as they finish each line, in order to check their own work. This is a most useful strategy to learn and the children should now be capable of it.

Teach them that if they exceed the required number, it is not only good to cross out the extra ones they have colored, but it also means they have been VERY clever. (See illustration.)



Related Activities

Continue to extend and generalize the concept of number in play and daily activities.

Games

Continue all learned games.

Section Six: Pages 24-29 — Motor Response to a Numeral (2)

It is easy to give children extra practice in this activity on scraps of paper.

Aim

1. As before, to respond correctly to a numeral.

This section is much more difficult than the previous one, however, as there is no structure within which to confine the response. The children are unable to count visible shapes, but have to create their own.

2. To reinforce and consolidate the strategy of checking their own work.

Procedure

The children may make marks with pencils, but they will really enjoy themselves and be very highly motivated if you allow them to use the self-inking stamps of happy faces or animals that are normally reserved for the teacher!

Show the children that there is one mark in the space next to "1".
two marks in the space next to "2".
three marks in the space next to "3".

Let them make marks/stamps over the existing spots.

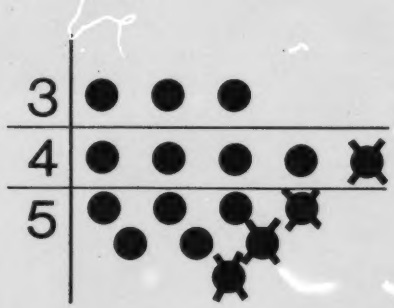
Next, give them a scrap piece of paper ruled in a similar way.

Let the children practise under supervision, then by themselves.

Numerals proceed sequentially until page 29, when extra practice is given with higher numbers.

Page 29 presents the children with more numerals, in half the space, out of sequence. By this time the children should have acquired the additional expertise and confidence to handle this. The insertion of "0" will also test the true internalization of the concept of zero and expose any pseudo-concept.

If the children did not make errors in the previous section, they are bound to in this one, particularly if they are using stamps! This will give another excellent opportunity to teach self-checking. Many children will perform accurately until they reach 4 or 5, when they will get carried away and produce far too many marks. Say, "How many should you have? . . . So we have 1, 2, 3, 4, 5, but we don't want this, or this . . ." (cross them out with the child). "Next time, *you* count and cross out the ones you don't need."



Encourage self-checking and correction.

Section Seven: Pages 30-36

Aim

1. To print numerals.
2. To order numerals.
3. To print a missing numeral in a string.
4. To respond to the concept of zero in a slightly more abstract form.
5. To respond to an early version of a number line.

Procedure

Show the children how to trace over the dotted numerals and fill in the missing numbers.

They may use the top line as a reference if they need to.

Models are always given of additional numerals.

The numerals are still related to pictures, so that the children are not counting without a referent.

On page 34, the concept of zero is reintroduced. It is now related to the number string. Show the children that there is no picture for zero!

Pages 35 and 36 not only give more practice in a "fun" setting, but also permit the children to order numbers without a referent for the first time. Do not draw their attention to this!

Games

1. Count the spots.
2. Race Track games with pack 2.

Using Games Card (12) to Learn to Read Written Numeral Names

If you wish to introduce the child to the written name of the numeral, use Games Card 12. The child counts the spots, turns the card over and, looking at the name, says, "This says (seven)." At the next stage they look at the name first, using the spots to check their answer.

Related Activities

If the child experiences difficulty, make huge numerals on the blackboard and let the child trace over it with a finger, so that the whole arm is involved.

A numeral may also be traced out in glue on card or other material and sprinkled with sand. This will make a rough surface over which the child may run the finger, increasing kinesthetic involvement and tactile stimulus.

Get a pile of counting picture books from the library and let the children read them tracing the numerals with a finger.

Section Eight: Pages 37-43 — Count and Print

Aim

To count the pictures and print the correct numeral in the space provided.

This section is the summation of all that has gone before. At this stage children should be able to combine all the skills they have learned effectively. They are now being required to count, remember what the appropriate numeral looks like and then print it. The pictures for counting have been placed in straight lines and in very

ordered arrays to ensure success. After they have completed this section, they should be able to generalize their skills and count anything to ten.

If a child is unable to print for any reason, do not hold that child back. Give the child the numeral cards to place in the boxes, or numeral stamps, so that lack of one specific skill will not inhibit the development of others.

Procedure

Let the children count the bus, say "One" and trace over the numeral.

Repeat with next two segments.

Numbers of pictures are presented in ordered numerical sequence until page 41, after which they appear at random.

Games

1. Race Track games.
   Use numeral card 3 as well as card 2.
2. *Introduce the Tens and Units games* — Fishing
   — Pirate ships.

   For directions see pages 4-5.

Section Nine: Pages 44-47 — Introduction to Ordinal Number

Aim

To identify the first of a given set of pictures and then order them numerically either from left to right or from right to left.

Each segment is made up of three component parts:
(a) figures;
(b) an arrow, which indicates which way the figures are going;
(c) ordinal numbers.
All of these are, once more, bound together by a strip of white or grey.

Prerequisite Skills:

The children should understand and be able to apply the concepts of "before," "after," and "last."

It is vital that the children have some experience of sequencing using concrete materials before they start this section.

Procedure 1

Concrete Experience:

It is suggested that the following activities might be useful:

(a) Stand the children in a line in order to move (to the library. . .). Say, "Tom will be the first. Bill will be after him, he will be second . . ."
(b) Play at going home on the bus. Stand in a line.
Ask who is first in the line?
Who will be last onto the bus?
Who will get on second? and so on.
(c) Have three children stand in a line at the teacher's desk.
Ask, "Who is first — second — third?"
Now have them turn round, so that the third is now the leader, and march

to a specified position at the other side of the room. Ask, "Who is the first now? Who is the last?" Repeat activity with different groups of children. Discuss how you decide who is in front or first and who is second and who last, or third. Why is it sometimes one and sometimes another?
Establish the concept of the relationship between direction and position. "The leader is the first."
Repeat this activity in as many different contexts as possible, constantly making the children observe which way they are going, who is in front, and that the child in front is first.

(d) While undertaking other classroom activities, use the language of ordinal number as much as possible, so that the children become familiar with it in context. "Susan, I'll look at your book first. John, you will be second," and so on.

(e) After demonstrating with the children themselves, use common classroom objects for sequencing activities. Colored building blocks may be arranged in a specific sequence — first the red one, second the blue one, third the yellow one . . . This activity does not have the same degree of intrinsic meaning as those mentioned above.

Note: If color or size is used in sequencing activities, make sure that the children have internalized that specific concept first, or they will fail to apply one concept because they have no knowledge of another.

(f) The children can color paper in strips vertically, following a model — "First this color, second this color . . ."

(g) Use pictures and photographs of lines of people. Ask the children to point to who is first, who second, who last?

DO NOT USE THE ACTIVITY BOOKS UNTIL THE CHILDREN CAN DEMONSTRATE THEIR ABILITY TO ORDER CONCRETE MATERIALS AND TO POINT TO THE FIRST, THE SECOND, AND THE LAST OF A PICTURED OR DIAGRAMMATICAL SEQUENCE.

Procedure 2

Using Books: THEN GIVE THE CHILDREN THEIR ACTIVITY BOOKS.
Repeat the instruction that all the white things belong together.
Tell the children that the arrow will help them see which way the people are going. The point of the arrow indicates the first. Now let the child trace over the dotted line which joins the man to the numeral, at the same time saying,
"First"
"First, second"
"First, second, third."
Pages 44 and 45 indicate that the children must count from left to right.
Page 46 demands that the children count from right to left.
Page 47 expects that the children will, helped by the cue of the arrow, alternate the direction of their counting.

Related Activities

Once the concept of ordinal number is established along a horizontal axis, it can then be applied in a general sense to vertical, up/down situations such as lifts, ladders, steps, and so on (see next section).

Section Ten: Pages 48-52 – Ordinal Number (2)

Aim

1. **To name specific ordinal numbers and to identify pictures in a line according to their ordinal position.**
2. **To demonstrate generalized understanding of ordinal number by ordering pictures from the bottom up and from the top down.**

The arrow is again included as a perceptual crutch.

Procedure

Ask the children to read the numerals and to circle the appropriate picture.

Page 52. The children should understand, because of previous teaching in concrete situations, that they can count both from the first downwards and from the first upwards.

Activity Book 2 — Addition and Subtraction (under 10)

Prerequisite Concept Teaching

It must be reiterated that it is of the utmost importance that all concepts be introduced initially within the natural setting of the children's own environment. Set up activities such as:

"Here are two leaves, now here are two more. How many do you have altogether?"
"Bring me a stone. Now bring me two more stones. How many do I have altogether?"
"There is a bird in that tree. Another bird has come. How many are there altogether?"

Then the concept can be introduced using familiar objects in the classroom:

"I have a drawing pin. Will you bring me three more? How many do I have altogether?"
"Get a pencil out of your desk. Now get another one out. How many do you have altogether?"

The same principle must be applied when subtraction is introduced:

"You have three crayons. May I have one? Now how many do you have?"
"Carol was playing with four cars. One has fallen off the table — how many does she have left?"
"John came to school with two gloves. He's lost one. How many does he have left?"

The following sections in the activity book are intended to translate actual concrete experience into two dimensions so that the children will once more move from the concrete to the abstract. It is important, however, that, having moved into symbolic representation, they are not allowed to lose sight of the concrete reality.

Section Eleven: Pages 1-4 — Introduction to Addition

Aim

1. **To combine two sets of concrete objects.**
2. **To add two sets of concrete objects to a sum not more than eight.**

It is hoped that objects used are commonly found in most classrooms for young children.

Further practice should be given using any other objects that are available.

Special Materials

Wax crayons, pencils, erasers, popsicle sticks, paper clips, buttons, drawing pins.

Procedure

Have the children first place one wax crayon on the picture.
Now let them put the other one on.
Ask them, "How many do you have ALTOGETHER?"
Let them print the answer in the "box".

Related Activities

Seize every opportunity to use addition in daily living.

Games

CONTINUE TO PLAY THE TENS AND UNIT GAME THROUGHOUT SECTIONS 11 TO 22.
Do not start the Race Track games with addition until the next section.

Section Twelve: Pages 5-9 — Addition to Eight with Diagrams and Color Cues

Aim

To combine two addends to make a sum of not more than eight, with the help of "number spots" and color cues.

Special Materials

Small counters to match the spots.
A plain card (or a "scanner") to place over the page, exposing only one computation.
[For note on construction of "scanner," see page 22.]

Procedure

Place the scanner over the first segment on the first page, or place a card over all the segments except the first.
Place two red counters over the two red dots and one (blue) counter over the one black dot.
Say to the child, "Tell me how many counters you have altogether?"
Show the child how to print his answer in the box provided.
Continue as above.

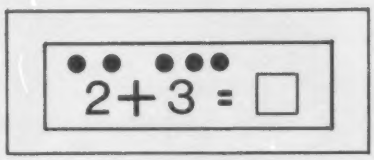
Note:
1. Let the children use the scanner or card until they discard it of their own volition.
2. The level of difficulty has been reduced as the level of abstraction has been slightly increased (counters instead of classroom objects).
3. The perceptual crutch of red and black spots which may be matched with counters is there for children to readily differentiate between the two addends. Children handicapped by perceptual problems may well, if not given this initial aid, add the same numeral twice. Many children who do not have perceptual problems may not need to match the different colored spots with different colored counters but may confidently use any available counters without difficulty.

Games

(1) Race Track games (car race, aeroplane race, space race, animal race) with Games Card 4 (pack of "simple addition with spots" cards to child's level). Children can choose the game and figures, but are given the pack of cards. See rules for game on page 4. Do not forget to explain to the children that the rules of the game have changed a little. They no longer only move the number they count on the dice or spinner, but they also move three places as a prize for getting the right answer.

(2) Tens and Units game.

Scanner: Some children may be unable to isolate the relevant segment from the whole visual field. These children may find a scanner helpful. This is a large piece of card with a segment cut out which fits over a single segment. The child slides this down the page, screening out irrelevant material.



Section Thirteen: Pages 10-14 — Addition to Ten

Aim

To combine two addends to ten with the help of a color cue.

Note: The level of difficulty has once again been reduced, as the children no longer have the red and black dots to match with counters. The level of abstraction has been slightly increased by the use of colored numerals alone.

Procedure

Some children may be able to complete these computations successfully, using counters if needed. It might help others to learn the strategy of placing their own dots in position.

For example, 2 + 1.

Games

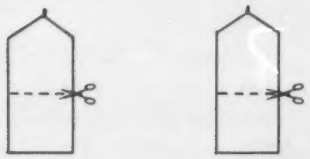
1. Race Track games (car race, aeroplane race, farm game, zoo game).
   Simple addition pack of cards (card 4 or 5 according to need). Game proceeds exactly as before.
2. Addition dice: to provide variety if required.
   Large dice may be used. Both have numerals 1 to 5 (see note at end of section). A third dice with the addition symbol on all sides may be used.
   Two or three children may play.
   They make (three) columns on a piece of paper, with their names at the top.
   The first child throws the three dice and does the computation.
   The child writes the answer in a correct column.
   The second and third children then have their turns.
   A tick is placed against the largest number in the horizontal column.
   The winner has the greatest number of ticks when the vertical columns are scanned at the end of the game.

SCORE CARD

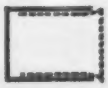
J	M	S
4	8✓	5
6	3	9✓
8	7	10✓
6✓	6✓	4
7	4	8✓
		↑

Winner!

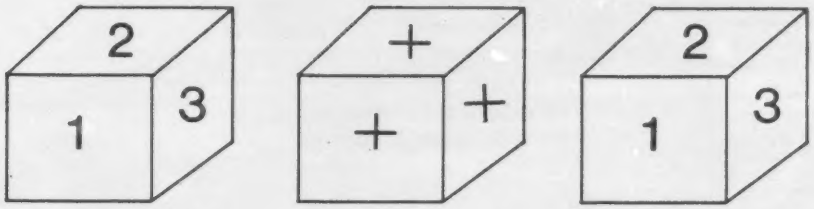
Note: Dice may be constructed from milk cartons.



(1) Cut two cartons in half



(2) Push one into the other



(3) Cover

Section Fourteen: Pages 15-18 – Addition to Ten

Aim **To combine two addends to a sum not exceeding ten.**

Procedure

Let the children proceed at their own pace.

Do not remove concrete aids; let the children reject them when ready.

If the children "add on their fingers," it is better to teach them how to do this properly than to try and stop them, as research shows that this is a normal thing for children to do at this stage of development. If you try and stop this, they will only do it under the desk!

Games

Race Track game with Games Card 5.

Section Fifteen: Pages 19-20 – "One More"

Aim **To count "one more" by "counting on" instead of counting each addend separately and then re-counting the combined addends.**

Procedure

First teach the children to "clap and say" one more:

Teacher: "I'll clap and count, and you clap and count one more."
"One (clap), two (clap), three (clap)."
Children: "four (clap)."
Teacher: "One-two-three-four-five."
Children: "Six."

Then work with the whole group using a big number line on the blackboard, for five-minute whole class sessions:

"John, what is that number?" (point to a numeral on line with ruler).
"Two."
"Now tell me what comes after two – what is one more than two?" (point to three with ruler).

The children realize after considerable practice that they do not need to go through the whole process of computation merely to add one.

As soon as the children are familiar with the use of the number line, give them their own personal number line to use as an additional aid, until it is no longer needed.

It is possible to individualize the teaching of each child when interacting with the whole group, by providing verbal and physical cues appropriate to the individual level.

For example, for child one – as described
for child two – only point to first numeral, let the child scan the number line to make the "jump" independently.
for child three – do not point at all.
for child four – see if it can be done with the eyes shut!

Games

Race Track using Games Card 6 (NOT LAST COLUMN).

Section Fifteen: Page 21—"Reversibility" Applied to "One More"

Aim

1. **To understand the concept of reversibility, applying it to the already learned skill of "one more."**
2. **To demonstrate knowledge that the sum of the two addends is always the same, no matter which way they are presented.**
3. **To recognize and use the "one more" concept when it is presented in reverse. This is an extremely important understanding.**

Procedure

Let the children work through examples on the blackboard.
See if anyone can see the pattern.
IF NOT, POINT IT OUT!

Games

Play Race Track games using all of Games Card 6.

Section Sixteen: Pages 22-23 – "Two More"

Aim

To equate the concept of "adding two more" with that of counting two along the number line, or "counting on" without going through the computation process using two addends.

Procedure

As for "one more."

Games

If you feel that the children need more practice using this skill, construct your own pack of cards.

Section Sixteen: Page 24 — Integrating "Reversibility" with "Two More"

Aim **To recognize the "two more" computation when it is presented with the two first and to apply the "reversibility" rule.**

Procedure

(1) Help the children to recognize that two more can be expressed as 2 + 4 as well as 4 + 2.
(2) Encourage children to reapply the reversibility rule which they have learned by looking at 2 + 4 and "thinking" 4 + 2.
(3) This will make it easy to "count on" two more.

Section Sixteen: Pages 25-26 — Reversibility Applied to Simple Addition

Aim **To apply the rule of the reversibility of like addends to all addition computations to ten.**

Procedure

Give the children the examples and help them to extract the rule.

Section Seventeen: Page 27 — Addition of Zero

Aim **To understand and apply the property of zero in addition.**

Children frequently make mistakes when adding zero, saying that X + 0 = 0. This error can cause great confusion both now and when more complex addition is attempted.

Procedure

1. "Act out" the concept of "adding zero" using concrete objects.
   "I have three pencils here, and zero pencils here, how many do I have altogether?"
2. Represent the concrete activities undertaken symbolically (as 3 + 0 = 3).
3. Help the children to see that if zero is added to any number at all, the sum stays the same as the number.

Games

1. Race Track games using Games Card 7 (not the last column).
2. Replace one of the numerals with zero on the dice and play the addition dice game as before (see page 22).

Section Seventeen: Page 28 – Integrating Addition of Zero with Reversibility

Procedure

Give practice examples and help children to "discover" the rule. They will find that it is easier to "think" 6 + 0 than "0 + 6."

Games

Race Track games. Games Card 7, incorporating last column.

Section Eighteen: Pages 29-30 – "Doubles"

Aim

To give an automatic response to computations involving identical addends.

It is most useful if the children can produce instantaneous answers to any computations involving doubles.

Note: This learning can be extended later to facilitate mental arithmetic through automatization.

For example, 5 + 6 = (5 + 5) + 1
7 + 8 = (7 + 7) + 1
8 + 9 = (8 + 8) + 1
and 7 + 9 = (7 + 7) + 2
5 + 7 = (5 + 5) + 2

Procedure

Learn through GAMES.

Games

Race Track games using Games Card 8.

Extension

When the children have successfully completed the addition section to page 30, it is appropriate to give them practice in combining different addends to make a specific sum. (Number families.)

For instance:

8	+	0	=	8
1	+	7	=	8
___	+	___	=	8
___	+	___	=	8
___	+	___	=	8

and so on.

When you introduce this activity, show the children how they can solve the problem.

For example, "Take out eight counters."
"You have 8 altogether."
"Now make two groups."
"How many counters in each group?"
"Well done. (4) and (4) make eight altogether."
"Now see how many different groups you can make."

Note: It is not considered appropriate to introduce the children to the problem

5 + ___ = 8 at this stage. To solve a problem such as this requires thinking at a more advanced level than the children have yet reached. The fact that children may not be able to solve this problem does not mean that they do not understand addition. They understand addition at a level which is entirely appropriate to their present level of functioning, but not yet at a level which involves knowledge of subtraction. Some children may have reached this level, but most will not yet be capable of the manipulation of number demanded by the task.

When children are functioning at a more advanced level and they need to be able to solve this sort of problem, there are two strategies which may be used:

(a) "Take eight counters" ___+___ = 8
"Make a group of five" 5 +___ = 8
"How many do you have left" 5 + 3 =
"How many do you have altogether" 5 + 3 = 8

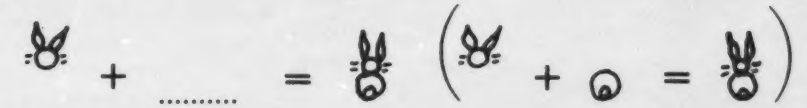
(b) "Counting on"
Teach the children to "count on" from the first numeral until they reach the sum. They can initially do this by making marks on paper if this is helpful.

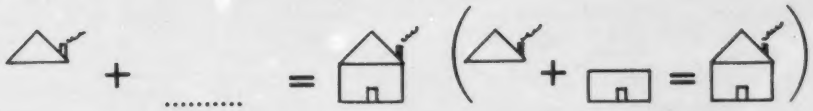
5 + 3 = 8 or even
5 + 3 = 8

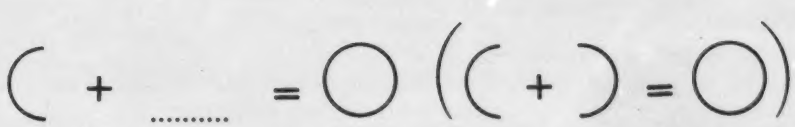
The strategy of finding the missing addend by subtracting the known addend from the sum is appropriate for children functioning at a later developmental stage.

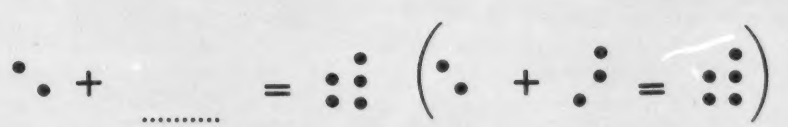
Children who do not understand the problem frequently respond to the symbol by adding the two given numerals together, producing results such as 3 + 10 = 7. It is important that the reasons for their answers are understood so that effective re-teaching may be given. It is obviously also important, at this later developmental stage, to enable the children to reach a deeper understanding of "equals". A simple way to do this is to use drawings or figures instead of numerals.

For example:









Section Nineteen: Pages 31-42 — Subtraction Below Eight with Diagrammatic Cues

Aim

1. **To understand and apply the concept of subtraction through interaction with environmental objects.**
2. **To understand and respond to the symbolic representation of this concept.**

It is not advisable to tell children that subtraction is the reverse of addition, as this will cause much confusion. They will reach this conclusion much later on when they are very familiar with the concept.

Procedure

The children should be introduced to the concept of subtraction through environmental objects.

It has not been thought necessary to illustrate this approach and it is left to individual classroom teachers to judge in their interaction with the children when they have grasped the basic concept of subtraction and are ready for the first stage of abstraction, using the activity book.

The children look at the page and first "read" the problem: "Two, take away one."

The children match two counters with the colored dots.

The children then "take *right* away" the counter on the dot which has been crossed out. It is emphasized that the counter must be picked up and placed in a totally removed geographic place (that is, back in the box) so that the child who has problems with fine motor co-ordination or organization in space does not become confused.

The children then count how many are left and place the answer in the box provided.

Pages 31 to 42 are all deal with in the same way.

Games

Race Track games using Games Card 13.

Section Twenty: Pages 43-50 — Subtraction Below Ten, Using Colored Symbol and Numeral as a Cue

Aim

To subtract any number from a given number not exceeding ten.

As the diagrammatic cues have been removed, the level of difficulty has been reduced initially to ensure success. The children are left with the minuend in black, to indicate the number of counters required, and the subtraction symbol and the subtrahend in color to remind the children that they are to take away that number of counters. The level of difficulty is gradually increased once more.

Procedure

As before.

1. The children will continue to use counters.
2. If they hesitate, forgetting what to do, reinforce the verbal cue — "Two, take one *right* away."
3. If individual children make errors which are due to poor organization, such as not

removing a counter far enough away and then re-counting it, superimpose more structure on the physical environment:

(a) Let the children put the counters in the segments of an egg carton and then take the required number *right out*; or

(b) Have all the counters in a jar. Take out the total number and when those to be subtracted are taken away, put them back in the jar.

4. If the children hesitate over subtracting zero, teach this as a separate skill, acting it out with concrete objects.

Section Twenty-one: Pages 51-55 — Simple Subtraction without Cues

Aim

To subtract efficiently after all cues have been withdrawn.

The level of difficulty is again reduced to ensure success now that the children are operating with no perceptual crutches.

Procedure

The children may choose to use any aid, or no aid.

If children use fingers, teach them to use them efficiently.

Do not forbid their use as using fingers to compute seems to be a natural developmental procedure. Fingers cannot be banned from a classroom and will be used surreptitiously if not overtly. It is better by far to teach the effective use of fingers as an aid for those who want it.

Page 52 is designed to ensure that the children understand that if the subtrahend is identical with the given number, the answer must be zero. If the children do not understand fully, go back to concrete objects.

Page 53 is designed to ensure that the children understand the concept of subtracting zero. Again, use concrete objects to reinforce understanding.

Games

(1) Race Track games, using Games Card 14.

(2) Subtraction dice (make as addition dice, page 23).
Make 1 dice with black numerals 5 — 10.
Make 1 dice with subtraction symbols.
Make 1 dice with red numerals 1 — 5.
Two or three children may play.
The children make (three) columns on a piece of paper, with their names on top.
The first child throws all dice and then places the black numeral dice on the left, the subtraction symbol in the middle, and the red numeral dice on the right.
The child completes the computation (using counters/number line, if necessary) and places the answer in the appropriate column.
Subsequent children then follow suit.
The child with the smallest number puts a tick against his/her name at the end of the round.
The child with the greatest number of ticks recorded in his/her column at the end of the game, wins.

SCORE CARD

J	M	S
4	8✓	5
6	3	9✓
8	7	10✓
6✓	6✓	4
7	4	8✓
		↑

Winner!

Section Twenty-two: Pages 56-68 — Learning to Change Concepts

Aim

To change from one concept to another at random.

Attention is focussed, through changing the color of the print, first on the whole computation and then on the symbol alone to help the children achieve this change of concept successfully.

The children are presented with simple addition and simple subtraction in sequences which are color cued. Addition is presented in black, subtraction in red. This is explained to the children, who are told that the change of color is to help them to remember to change from addition to subtraction.

Pages 56, 57, 58. The computations are presented in blocks of three, differentially colored.

Pages 59-62. The computations are mixed at random but still retain the color cue throughout.

Pages 63. Only the subtraction symbol retains the color cue. Computations are once again presented in blocks of three at a fairly low level to ensure continuing success.

Pages 64, 65. The computations are again randomly mixed.

Page 66. The color cue is removed.

Page 67. The children are required to integrate the skills of adding like addends (doubles) and subtracting a subtrahend which is the same as the original number with the skill of changing from once concept to the other.

Page 68. The children are required to integrate the skills of adding and subtracting zero with the skill of changing from one concept to the other.

Games

(1) Race Track games. Mix Games Cards 5 and 14.
(2) Dice game.

In the early stages, print the numerals 0 — 5 in red on one dice, and the numerals 5 — 10 on the other in blue. Make a dice which has + and — on alternating sides. Teach the children to place the "blue" dice on the left and the "red" dice on the right. This will enable children to change concepts without the additional pressure of having to think which number you subtract from which.

Activity Book 3 — Tens and Units

Section Twenty-three: Pages 1-3 — Tens and Units (Tens and Ones)

Aim

To develop a fundamental and functional understanding that numbers above nine are grouped into lots of ten, and ones.

It is much more important that children should have this understanding than that they should be able to name the numerals. Once they have acquired the first understanding, the second skill will follow later. It is hard for children to learn "thirteen, fourteen, fifteen . . ." by rote. It is much easier to conceptualize "One lot of ten and three ones, one lot of ten and four ones, one lot of ten and five ones . . ." and just as easy to conceptualize "Four lots of ten and six ones" or "Nine lots of ten and eight ones . . ." By learning number in this way, as soon as children can group a lot of ten together, those children are capable of comprehending number to one hundred — or "Ten lots of ten."

If the children are taught to think about number in this way and to write the numerals in the format suggested below, then subsequent tendencies to reverse the printing of numerals will be forestalled and will not occur.

3	7

This learning will lay a solid and unshakable foundation for later advances in mathematics, so much of which is dependent on this very concept.

Special Materials

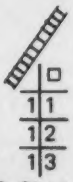
Diennes blocks are one of the most useful and sound mathematical aids that one can use. Unifix cubes are also an excellent concrete aid to understanding. Construct columns of ten and use in conjunction with the "one" cubes. This sort of aid will give the children an accurate mental image of "tens" and "ones" which should not

initially be conveyed through one cent coins and ten cent coins, or other such aids, which the children can relate to at a later stage, but which will be confusing now.

Procedure

If the children have already been playing the Tens and Units games (Pirates and Fishing, see pages 4 and 5), then they will already understand this concept and will go straight into the pages of this book with no further introduction. If they have not yet played this game, teach them to play it at once and they will soon be completely at home with the concept. You can also proceed like this:

- Count out ten unit cubes.
- Place them in a vertical line.
- Tell children you are going to do some magic.
- Children shut eyes – quickly exchange units for ten column (or stick the unifix cubes together).
- Children open eyes – say that magic has stuck the ones together!
- Let children play with the columns and cubes.
- Let them match ten unit cubes with one ten column.
- Let children count sections on ten column.
- Take one lot of ten and one – write on paper or on the board
- Take one lot of ten and two ones, write under previous numbers.
- Take one lot of ten and three ones..... 13.



- Count sections on the ten column and then the ones . . . 10, 11, 12. Show children the correlation.
- When children have considerable interaction with these materials, give them Activity Book 3.

Pages 1, 2, 3. Tell the children that the "lots of ten" are written in red and the "ones" in black.

Let the children construct, or choose, and set out, one lot of ten and two lots of one.

Let the children print 1 in the "tens" column and 2 in the "ones" column.

Tell the children the names of the number when they have finished a page and are looking at it – "One lot of ten and two ones, that's twelve." And so on.

Games

Tens and Units games – (1) Fishing
(2) Pirate Ships game.

The rules are on pages 4 and 5.

Related Activities

Let the children make lots of ten with Unifix cubes and then set out their own numbers, writing them down after they have set them out.

Give the children several random combinations of tens and ones to count and print.

Section Twenty-four: Pages 4-12 – Addition with Tens and Ones

Aim

To give an instantaneous response based on understanding of the concept.

Note: Children should not be given this unit until they have completed the section on tens and units and have played the Tens and Units game, so that they have a soundly based and unshakable concept of tens and units.

Each concept must, therefore, be presented using the concrete aids to ensure understanding.

Children will then be able to print the answer in their books without actually carrying out the computations, but thinking rather of "one more lot of ten" or of combining tens with ones.

This will later facilitate the children's skill and speed or response when dealing with money, as well as greatly increasing their ease of manipulation of number.

Special Materials

Diennes blocks or Unifix cubes.

Procedure

Pages 4, 5. Show the children that all they have to do is combine one lot of ten with one — 11. Once they understand this, they will not need any concrete aids and will produce answers as fast as they can print.

Pages 5, 6. Integrate the concept of reversibility.

Pages 7, 8. Demonstrate to the children that they can immediately combine two lots of ten and six — 26.

Page 9. Integrate the concept of reversibility.

Page 10. Show the children that this is simply "one more lot of ten."

Page 11. Integrate the concept of reversibility.

Page 12 will indicate whether the children have thoroughly understood the concept. Use any errors as an indication that further consolidation and practice is needed.

Games

(1) Continue to play the Tens and Units game.

(2) Games Cards 9, 10 and 11 may be used with any Race Track game to consolidate these concepts. The last column of each card gives practice in reversibility and should not be added to the pack until this has been taught. Use each pack until the children can give the answer "without thinking."

Section Twenty-five: Pages 13-21— Simple Addition Leading to Addition with Regrouping

Aim

To apply knowledge of tens, ones, and place value to combine addends which require regrouping.

Special Materials

Diennes blocks or Unifix cubes.

Procedure

Page 13 introduces the children to "addition the other way up." This will be very simple for the child who has mastered the prerequisite skills. It is advisable, however, to teach the children to place the appropriate number of "one" cubes in position — one set above the other — even if this crutch is not at the moment necessary. It will aid understanding at the next stage.

Page 14 introduces one set of ten into the computation. The set of ten is color-cued red so that children can distinguish it from the set of ones. This color cue will also relate this concept of ten back to the original framework of tens and ones, with which the children are familiar. The children will place the "ten" and the "one" cubes in appropriate positions before putting them together to add them up.

Page 15. Zero is introduced into the computation.

Page 16. Two or more sets of ten and two sets of ones are then introduced. The children must still use the aids in the manner indicated. The level of complexity is now built up gradually.

Page 17. The concept of regrouping is then introduced. The teacher should watch the children as the "one" cubes are added together. The children will find that there are more than ten. Say, "You cannot have a lot of tens with the ones, so where do you think it ought to go?" The children will think for a moment and invariably reply that it must go with the tens! Show the children how to "trade in" the ten lots of one for one lot of ten, and place it with the lot of ten already in the "tens" column. Addition then proceeds as usual. Although the concept of ten has been introduced, thus increasing the level of difficulty, the computation has been made as simple as possible by the use of one set of ten only in the tens column.

It has been found that the use of the color cue, combined with the interaction with the concrete aids and the children's already internalized understanding of the concept of tens and units, will carry them over this hurdle with no difficulty. Further pages simply gradually increase the level of difficulty.

Page 19. Two columns of tens and ones are reintroduced.

Page 20. The color cue is then withdrawn, but at this point the level of difficulty is once more reduced to enable the child to handle this without stress. The level of difficulty is once more built up until the children are operating at a high level of difficulty without cues.

Note: Some children find it helpful to print "+1" onto the "tens" numeral when they regroup.

Games

Continue to play the Tens and Units games.

Section Twenty-six: Pages 22-34 — Simple Subtraction Leading to Subtraction with Regrouping

[THIS SHOULD NOT BE INTRODUCED UNTIL THE CHILDREN HAVE COMPLETED THE SECTION ON ADDITION WITH REGROUPING.]

Aim

To understand and successfully undertake the process of subtracting numbers which demand the decomposition of tens.

Special Materials

Unifix cubes

Procedure

Page 22 introduces the children to "subtraction the other way up." The children must be taught to place the appropriate number of "one" cubes in position at the top of the column. It must be stressed that the numeral below is to be taken away, and therefore NO CUBES ARE TO BE PUT OUT. It is vital that the children who have successfully completed "addition the other way up" do not become confused.

Page 23 introduces one lot of ten into the computation; it is color-cued. The color cue will relate the concept of ten back to the original framework of tens and units with which the children are very familiar.

Page 24-25. Additional practice is given at this level.

Page 26-27. The concept of regrouping is then introduced. The children will be puzzled at first, because it is not possible to take "two ones" from the "one." The

children are reminded that they have a lot of ten on the other side. They trade it in for ten lots of one, and proceed with the computation.

Page 28. The introduction of zero to the "ones" column must be monitored.

Page 30. The color cue is dropped and the level of difficulty is also dropped to ensure success. It is gradually built up again until the children are functioning at the maximum level of difficulty within this range.

Page 31. The level of difficulty is built up as more than one lot of ten is introduced.

Page 32. Regrouping is once more required.

Page 33. Further practice is given with zero in the "ones" column.

Page 34. The children are required to subtract both ones and tens.

Section Twenty-seven: Pages 35-40 — Learning to Change Concepts when Carrying Out Addition and Subtraction with Regrouping

Aim **To change from the concept of addition with regrouping to that of subtraction with decomposition without confusion.**

This section follows the pattern of the previous section in Activity Book 2, pages 56 to 68. It must not be attempted until the children are proficient both in addition and subtraction to the highest level.

A color cue is provided to assist the children, as the change of procedure at this level requires great concentration.

Activity Book 4 — Multiplication and Division

Section Twenty-eight: Pages 1-8 — Multiplication: Combinations to Twelve with Diagrammatic Cues

Aim

To understand and apply the concept of multiplication, moving from concrete objects to abstract representation with diagrammatic and color cues.

Multiplication is introduced as a separate skill, rather than as repeated addition, so that children do not become confused. Children frequently make this connection later after they have become very familiar with the algorithm.

Special Materials

Concrete objects such as pencils, plastic farm animals, buttons, counters, and so on. Bangles/jar lids/rubber bands/paper plates, as available.

Procedure

Introduce the concept socially. "Here are four children. They each have two pencils. How many pencils are there altogether?"
"Take a partner. Now we've got three lots of two children. How many children are there altogether?"

Give the children a lot of practice with concrete materials.

Take paper plates or lids or bangles and a box of toy animals. Say, "Now we'll make two lots of three animals."

Put out two (plates) then put three animals on each.

Repeat, using many different combinations of numerals, until the children automatically equate the "lots of" with the (plates). At this point introduce the children to the written computation 2 x 1; equating the red numeral and symbol with the words "two lots of . . .", and the black numeral with the number of objects on each plate.

Now complete the computations by asking, "How many do we have altogether?"

Pages 1-8. Finally, introduce the children to page 1. By this time it should be easy to know how to set out the rings and complete the computation, by counting the total number of objects.

Games

Race Track games using Games Card 16.

Section Twenty-nine: Pages 9-12 — Simple Multiplication with Color Cues Only

Pages 9-12. Page 9 introduces the children to color-cued numerals with no diagrams. The level of difficulty has been reduced to ensure success.

Section Thirty: Pages 13-17 — Simple Multiplication/ Multiplication with Zero/Reversibility

Page 13. The color cues are removed and so the level of difficulty has once more been reduced.

Page 15. The concept of multiplying zero is introduced. IT IS VITAL THAT THIS NOT BE CONFUSED WITH ADDITION OF ZERO. Do *not* compare, unless the children do, but demonstrate, and let the children experiment with, the concept, until you are totally confident that they understand it. They should then be able to do it "without thinking."

Pages 16-17. The concept of reversibility in multiplication is demonstrated. If this concept is thoroughly understood, the number of multiplication facts to be learned will be reduced by half!

Games

Race Track games using Games Card 17.

If you feel the children need extra practice in the concepts, construct a pack of cards for X 0. Tables may be learned through the introduction of packs of "tables" cards. Cards 18 to 22 will give you a start. Only introduce three new cards at once to accelerate learning.

Note: Where playing the games with multiplication cards, TEACH THE CHILDREN TO CHEAT — in other words, to say the computation ("Two times three" or "Two threes," or whatever you wish) and LOOK AT THE ANSWER as they say it. They then repeat the whole computation once more aloud before moving on three places.

They will learn *much* faster if they look and say the answer than if you allow them to risk a wrong answer.

Section Thirty-one: Pages 18-24 — Division Below Twelve with Color and Diagrammatic Cues

Aim

To divide sets into equal subsets, stating how many subsets have been made.

Special Materials

Concrete objects (plastic animals, pegs, blocks, counters, popsicle sticks, and so on). Circles (bangles, string, and so on).

Procedure

Introduce the concept of division socially in the classroom:

"Here are twelve children. If we divide them into groups of four, how many groups will we have?"

"You are going to have two pencils each. Here are twenty pencils. Will you divide them into groups of two, and tell me if we have enough?"

Give the child much practice with concrete objects, using the word "divide":
"Here are six pencils. Let's divide them into groups of two. How many groups have we made?"
"Here are six sheep. Let's divide them into groups of two. How many groups have we made?" And so on.

When the groups have been made, put the rings over them to emphasize the distinctness and the number of separate sets. Repeat this exercise using counters. This will lead directly into page 18:
"Put out six counters."
"Now make groups of three. How many groups?"
"Now make groups of two. How many groups?"

Pages 18 to 24 continue to give the children practice at this level.

Games

Any Race Track game using Games Card 23.

Section Thirty-two: Pages 25-30 — Division Below Twelve with Color Cues

Procedure:

The cue of the divided sets is removed. The children are left with the cue of colored numerals only, but the level of difficulty is reduced to ensure success.

Let the children continue to use concrete aids if they wish, or help them to "make their own spots" to arrive at the answer.

For example, (1) $6 \div 2 =$ (2) $\overset{111}{6} \div 2 = 3$ or (3) $\overset{\ominus\ominus\ominus}{6} \div 2 = 3$

The children will still use the verbal cue, prompted by the color change, "divide into groups of (2)."

Pages 31-32. All cues are now removed.

Games

Race Track games with Games Card 24.

Activity Book 5 — Money

Section Thirty-three: Pages 1-18 — Coin Recognition and Combination

Aim

1. To recognize 1¢, 5¢, 10¢, 25¢, 50¢, and $1 coins and to combine any of these together to make a sum to $1.
2. To choose appropriate coins from an array to make a specific sum.

Special Materials

REAL COINS.

Procedure

Give the children much practice in counting with one cent coins. Draw the children's attention to the numeral "one" on the one cent coin. Tell them it is also called a "penny". Show them the maple leaf.

Page 1. When you give the children the first page, also give a pile of coins.

The children should pick out the one cent coins and match them with the pictures.

Make it quite clear to the children that when the coins are added together, it is just "adding numbers together like any ordinary sum!"

Show the children the pictures at the bottom of the page.

Say, "Can you see how much this thing costs?"

"Can you circle the cents you will need to buy it?"

Demonstrate how to do this on the blackboard.

Let the children try the example on the page, circling over the dots.

Page 2. Then let them work on by themselves.

Page 3. Make piles of five one-cent coins.

Show them the five cent coin, drawing their attention to the beaver and to the numeral 5. "This five cent coin stands for 5 one cent coins."

Give the children practice in trading in five one cent coins for a five cent coin (see Money game).

Tell them it is also called a "nickel."

Pages 4-17. Use the same methods throughout these pages until page 17.

Continue to allow the children to set out the real coins on the pages until they no longer want to bother to do this.

Money Game:

(1) Use the Race Track games with Game Card 25.

(2) *Tracing game*

No board needed.

Use quantity of small "treasures" between two children.

(a) One cent and five cent coins.

Use six-sided spinner or dice.

First child throws dice and picks up appropriate number of one cent coins.

If 5 or 6 is thrown, the child trades in appropriate number of one cent coins for a five cent coin and "buys" a treasure. Change is kept towards next turn. Second child follows suit.

(b) Same procedure is used with 10¢, 5¢, and 1¢ coins,
25¢, 10¢, 5¢, and 1¢ coins,
50¢, 25¢, 10¢, 5¢, and 1¢ coins
using either two dice or the nine-spinner and allowing the children to pick up the coins in whatever kind they wish, but always "trading in" to acquire the highest level of coin currently in use.

(3) "Shops." Play "shops," pricing goods at the shop, according to the level of understanding reached by the children.

Section Thirty-four: Pages 19-20 — Introduction to Change

Aim

To understand and apply the concept of receiving change.

It is extremely difficult for children to work out mentally how much change they should be giving or receiving. The children are being asked, in effect, to carry out subtraction with regrouping without the benefit of pencil and paper. Children who can competently operate using the concept of tens and ones will find this skill much easier if they are taught to think in these terms and subtract to the nearest ten and then add the extra five or ones. This section is designed to give children an initial understanding of this technique, combined with the technique of using an instantaneous response to common combinations — such as 25+25+25+25.

Procedure

Let the children take the exact coinage or note shown on the right-hand side of the picture on the left of the page (the amount which is being offered in exchange for the goods).

Show the children how to change this into the appropriate number of component coins in a manner which will "match" the price tag. They can then reduce the amount shown as the price into the same component coins.

The two are matched up, and the difference constitutes the change. If the initial coinage has not been reduced sufficiently to allow this to happen, the last coin can be further broken down to make matching possible.

This small section is only intended to demonstrate to the children exactly what is happening when change is given, and to suggest two possible techniques which can be developed and made more readily accessible through practice.

Activity Book 6 — Time

Aim

To relate positions on the clockface to the appropriate "time."

This activity book will teach students the mechanics of time-telling. It will not teach children to relate the time of day to different events or to develop a sense of time span. Most children, however, have an innate sense of "Time to eat!" or "Time to go home!", and it is relatively easy to tie the telling of time to the passage of time once children are proficient in the former skill.

The advent of the digital clock has rendered many previous modes of time-telling obsolete. It is universally valid and acceptable to use the format 6:25, 8:40, 3:55, and so on. This mode of time-telling also relieves children of all the confusion which used to arise with "before," "after," "to," and "past."

The twenty-four-hour clock has not been chosen because although this may be internationally acceptable, very few clock or watch faces use this format.

It is also considered that the children should learn to tell the time in such a way that they are not dependent on numeral recognition, as very many watch faces do not have any numerals on them at all.

Normally, the child moves from the simple to the more complex. This method of time-telling apparently reverses this natural progression. It has been found that if children learn the "hours" first, some may "get stuck" and find it extremely hard to relearn the sequence using much less "natural" numbers! If, however, when the children first encounter the learning of time-telling in school, they immediately internalize the 5-10-15 . . . sequence, relating this to a position in space, this problem does not arise. They can confidently relate the "4" position to "twenty" without thinking and are able to retain this without difficulty when relating the "4" position to "four". Thus, the apparently harder system is actually much easier than the "easy" one!

Section Thirty-five: Pages 1-7 — Counting by Fives around the Clockface

Procedure

Give older students the activity book to work through on their own. They will need direction only at the beginning.

If time-telling is being taught in a Grade 1, 2, or 3 class, the quickest and easiest way for the children to learn is in a whole-class oral situation for five minutes each day, following the format indicated by this activity book.

Pages 1-7. Draw a circle (clockface) on the blackboard similar to that on page 1. Do not print any numerals.

- With a "pointer" indicate the "5" position, saying "Five!"
  indicate the "10" position, saying "Ten!"
  indicate the "15" position, saying "Fifteen!"

Repeat three or four times together.

- Point at random to any of these positions, until the children can say the appropriate numeral when its position is indicated.
- Add "20" when the children have acquired instantaneous response to 5-10-15.
- Continue in this manner around the clockface until each number in the string can be assigned to its specific position in space.
- Do this by:

(i) starting each session by counting around the clock; teacher points as children count.
(ii) giving individual children turns; help them if they falter.
(iii) pointing at random to different positions; give individuals a turn to answer. Give them appropriate cues according to level of functioning., e.g.

1. Point and count *with* the child.
2. You point, child counts.
3. Point to required numeral. *Say* nothing, but point around the clockface until that numeral is reached.
4. Point to required numeral. Give time for child to count internally.
5. Point and get instantaneous response.

Games

Race Track games, using Games Card 26.

Section Thirty-six: Pages 8-10 — Continuing to Count by Five when Looking at 1, 2, 3 . . .

Page 8. The "inside" numbers are now introduced as a distractor, but the children continue to count "the outside numbers" exactly as before.

Note that on the cards the "outside numbers" are colored red as a visual cue.

If this activity is being conducted orally, say, "Now I am going to point at the inside numbers, but I want to go on counting the outside numbers," and make sure you start the children off the first time, saying, as you point to 1, "Five," and to 2, "ten" . . .

Page 9. The long (red) hand is now associated with the "outside numbers." The children are taught to write the outside number AFTER a point, .5, .10, .15, and so on.

Section Thirty-seven: Pages 11-16 — Counting the Hours (Inside Numbers)

Pages 11, 12, 13. The children learn to count the "inside numbers", associating these with the small hand. They will accomplish this very quickly!

Page 14. The children learn to say the correct number, regardless of the format. These clockfaces are all commonly found in public places and homes today.

Page 15. Very often there are no markings on a clockface except indentations.

Page 16. The children have to learn to "see the circle" inside any other shape.

Section Thirty-eight: Pages 17-19

Pages 17, 18. This is the h[illegible]tion. The children must learn that if the small hand points to any place between two numerals, the first of these must be named.

Give the children a verbal cue which they can repeat to themselves:
"Anywhere between one and two is one."
"Anywhere between two and three is two."
"Anywhere between three and four is three" . . .

Page 19. The cue of the shaded segment is removed.

Games

Race Track with Games Card 27.

Section Thirty-nine: Pages 20-24

Now all that has to be done is to put together the two skills that have been learned.

Pages 20, 21, 22. The color cues are provided to help the children until they are able to "read the clock" without thinking.

Pages 23, 24. Some practice with no cues.

Games

Race Track games with Games Card 28.

- MAKE SURE YOU GIVE PRACTICE IN REAL SITUATIONS WITH REAL CLOCKS AND WATCHES – AS MANY DIFFERENT SORTS AS YOU CAN FIND!
- RELATE THE TIME OF DAY TO EVENTS AND EXPECTATIONS.
- RELATE SPECIFIC SPANS OF TIME WITH THE AMOUNT OF TIME IT TAKES TO
  - (i) walk around the playground.
  - (ii) do a puzzle.
  - (iii) eat lunch, and so on.

Activity Book 7 — Equivalents and Fractions

Section Forty: Pages 1-4

Aim

To demonstrate understanding of equivalence of size, shape, and number.

This understanding is essential before attempting to work with fractional number, as the children must clearly comprehend that the "pieces" of a fraction must be the same size.

It has been found that children invariably find working with fractions great fun. They seem to have no difficulty in grasping the concept at this elementary level and applying it in real life situations.

Special Materials

- Attribute blocks.
- Cardboard shapes. Some should be the same and some different in both size and shape.

Procedure

Let the children play with attribute blocks, sorting them into like sizes and like shapes.

When the children can do this successfully, give them cardboard shapes. Let them sort out all the triangles, squares, rectangles, circles, and so on.

Introduce them to the same shapes of different sizes.

Let the children match the shapes and sizes by placing one on top of the other.

Encourage the children to say, "This (triangle) is equal to that one."
"This (triangle) is NOT equal to that one."
"This square is NOT equal to that rectangle."

And so on.

Now draw the shapes on the blackboard and introduce the children to the symbols.

△ = △ ○ ≠ ○

"This triangle is equal to this triangle." "This circle is NOT equal to this circle."

As you say "NOT" put the diagonal line through the equal sign. Give practice, letting different children make the appropriate symbol on the board.

When they are able to match equivalent shapes on the board, give them similar practice in matching equivalent numbers of shapes:

○ ○ ≠ ○ ○ ○

Section Forty-one: Pages 5-10 — Fractions: Equal Parts of the Whole

Aim

To demonstrate the understanding that fractional number represents equal parts of a whole number, by discriminating between whole and fractional number and identifying and correctly representing different denominators.

Special Materials

Licorice Allsorts!

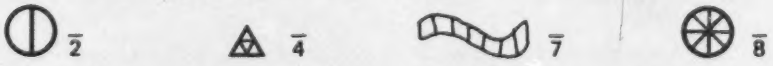
These are essential and can *not* be replaced by apples, cakes, or anything else! If you use licorice allsorts, you will allow your students to form in their minds a magnificent visual image, or analogue, of a fraction which will enable them to carry out operations on fractions later on with ease. The fact that the licorice allsorts are one whole divided into equal parts (even providing the visual cue of different colors) gives the student a clear and unequivocal representation. It is important also that some of the sweets should be divided unequally into parts, as these must be rejected — an important learning! Do not blur the analogue by equating it with imprecise images of apples and cakes; this will only confuse the students. You will only need to use the licorice allsorts about four times to illustrate different key features of fractions. After this the image will suffice.

Procedure

- Show the children one licorice allsort without letting them look too closely at it, and ask them how many sweets you have. Then let them look at it closely and tell you how many parts there are.
- Now let them decide whether the parts are the same size. If they are not, discard it, saying you can't use it for fractions.
- If the parts are the same size, say, "Good. One sweet, with (four) parts. This is how we write the parts . . ." $\frac{}{4}$
- Repeat with about six different licorice allsorts, always moving from ONE sweet to (three) parts, and writing the parts: $\frac{}{3}$ $\frac{}{6}$ $\frac{}{2}$

- Always stress that the parts must be the same size. Use as many different "parts" as possible (fix them up before the lesson!).
- Now ask individual children not only to tell you the number of parts, but also to write the answer on the board themselves.
- Now *draw* the shape of the licorice allsort on the board and go through the same process, using the diagram instead of the actual sweet:

- Now introduce different shapes, so that the children move away from the rectangular shape to as many other shapes you can think of, varying not only the shape, but also the number of parts, and always asking different children to write the answer. Make sure the parts are the same size.



Pages 1-10. The children are now ready to work on these pages independently.

Section Forty-two: Pages 11-14 — Introducing the Numerator

Procedure

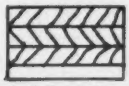
Introduce these pages by going back to the licorice allsort. Hold up one sweet and say, "How many sweets?" "one". Then say, "How many parts?" "(Four) parts."

Now peel off the top layer and say to a child, "I'm going to give you one of the (four) parts and write down $\frac{1}{4}$ — (one of the) (four parts)

and to another, "I'm going to give you (three) of the four parts

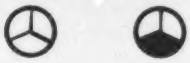
$\frac{3}{4}$ — (three of the) (four parts)

Do this a few times with different combinations of different licorice allsorts. Then transfer to the blackboard and draw equivalent diagrams.



I've shaded 3 of the 4 parts

I've shaded 1 of the 2 parts



"You shade 1 of the 3 parts"

"You shade $\frac{5}{6}$"

Pages 11-14. The children will now be ready to work independently through these pages. Say, "Tell me how many of the parts I have shaded?" The children identify and write down the fraction.

Section Forty-three: Pages 15-18

Pages 15, 16. The children shade the fraction appropriately.

Pages 17, 18. The children are required to draw the appropriate number of parts and then shade the right number.

Children might need help in finding out how to divide a circle into equal parts.

At first they will almost inevitably do it like this

Show them the easy way!

Note: Some children might have problems when drawing their own fractions on pages 17 and 18 for a variety of reasons unconnected with their understanding of the concept (poor motor co-ordination, for instance). Do not prevent them from continuing to make progress, just skip these two pages.

Section Forty-four: Pages 19-25 — Equivalent Fractions

Procedure

GO BACK TO THE LICORICE ALLSORTS!

Take one with two parts — peel one part off — you have one of the two parts $\frac{1}{2}$.

Put them together again — now you have two of the two parts $\frac{2}{2}$.

When you have two of the two parts, you really have one whole $\frac{2}{2} = 1$.

Repeat with different combinations.

One activity the children enjoy is to divide the class into three teams, make three sections on the blackboard, and when you say "Go," let a representative from each team run to the board and write, "As many ways of writing 1 as you can." Give a prize to the most and a prize for the most original!

$1 = \frac{2}{2}$ $1 = \frac{3}{3}$ $1 = \frac{7}{7}$ $1 = \frac{4}{4}$ $1 = \frac{5}{5}$	$1 = \frac{6}{6}$ $1 = \frac{10}{10}$ $1 = \frac{1}{1}$	$1 = \frac{168}{168}$ $1 = \frac{768}{768}$ $1 = \frac{2395}{2395}$

When the children are thoroughly at home with this concept, then extend them further.

Take one licorice allsort $1 = \frac{3}{3}$

Now cut it in half. You now have $\frac{6}{6}$ equal parts.

But if you stick it back together again, you still have $\frac{3}{3}$, so, $\frac{3}{3} = \frac{6}{6} = 1$

You can even cut it in half again, and you will have

$\frac{12}{12}$, so $\frac{3}{3} = \frac{6}{6} = \frac{12}{12} = 1$

Go on exploring this relationship with many different examples, moving from the concrete, to the diagram, to the symbol (abstract).

See if the children can detect what is happening – if not, show them that each time the numbers double!

$\frac{2}{2} = \frac{4}{4} = \frac{8}{8} = \frac{16}{16}$; $\frac{3}{3} = \frac{6}{6} = \frac{12}{12} = \frac{24}{24}$, and so on.

This is a most important understanding. Many children find it hard to understand that $\frac{1}{12}$ is smaller than $\frac{1}{2}$ when they know that twelve is bigger than two.

Children taught this way will have no problem, as they can see for themselves that one of the "twelve parts" is much, much smaller than one of the "two parts."

It will be easy now to show the children that one of the two-parts can be cut into two of the four-parts. Give them many examples and let them experiment with card cutting to see what happens (remembering that the parts must be the same size).

Pages 19-22. The children should now be ready to move into these pages with complete understanding.

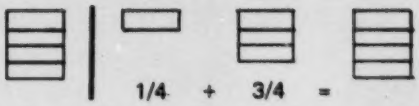
Pages 23-25. Tell the children that there are TWO right answers for them to find.

Section Forty-five: Pages 26-29 – Addition of Fractions

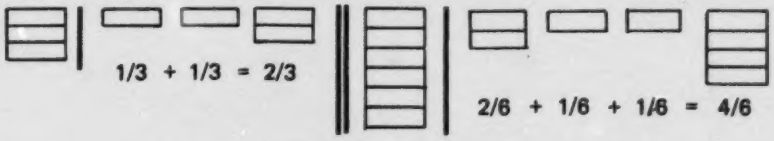
Procedure

Once more, go back to your licorice allsorts.

It is very easy for the students to understand that if you have one sweet, and you give one child one of the four parts, another child three of the four parts, and then instead of letting them eat the parts, ask for them back and stick them together again, then you will once more have all four parts, or one sweet.



Give several examples, making sure that they do not all add up to a whole sweet!



IF YOU ECONOMIZE ON THE LICORICE ALLSORTS, THE CHILDREN WILL NOT LEARN NEARLY AS FAST NOR HALF AS WELL! The analogue is superb!

Once again, move to the diagrammatic form before you let the children work independently in their books.

Page 26. Simple addition with diagrammatic support.

Page 27. Addition presented in the symbolic form only.

Page 28. Addition of whole numbers and fractions is introduced, once again with diagrammatic support.

Page 29. Addition of whole numbers and fractions are presented without the support of diagrams.

With this sort of fundamental understanding of what we actually mean when we talk about whole numbers and fractions, and what happens when they are added, it is easy to take the next step into denominators which must be "made the same" before they can be put together.

Section Forty-six: Pages 30-32 – Subtraction of Fractions

Procedure

For the last time, return to the licorice allsorts to make the process which is involved in subtraction of fractions quite clear to the children.

Take one sweet with four parts, take one away, and you only have three parts left!

Quickly translate into diagrammatic form and let children show you how well they can do it on the blackboard, before allowing them to work independently in their books.

Page 30. Subtraction of fractions with the support of diagrams.

Page 31. The children should be able to continue to experience success without the support given by the diagrams.

Page 32. The children subtract whole numbers and fractions, first with diagrammatic support and then without it.

Once again, it should be easy to build on these foundations to extend the children's capacity to operate on fractions with success.

- Games Kit
- Teacher's Guide
- Activity Book 1: Counting to Ten

  Activity Book 2: Addition and Subtraction (under Ten)

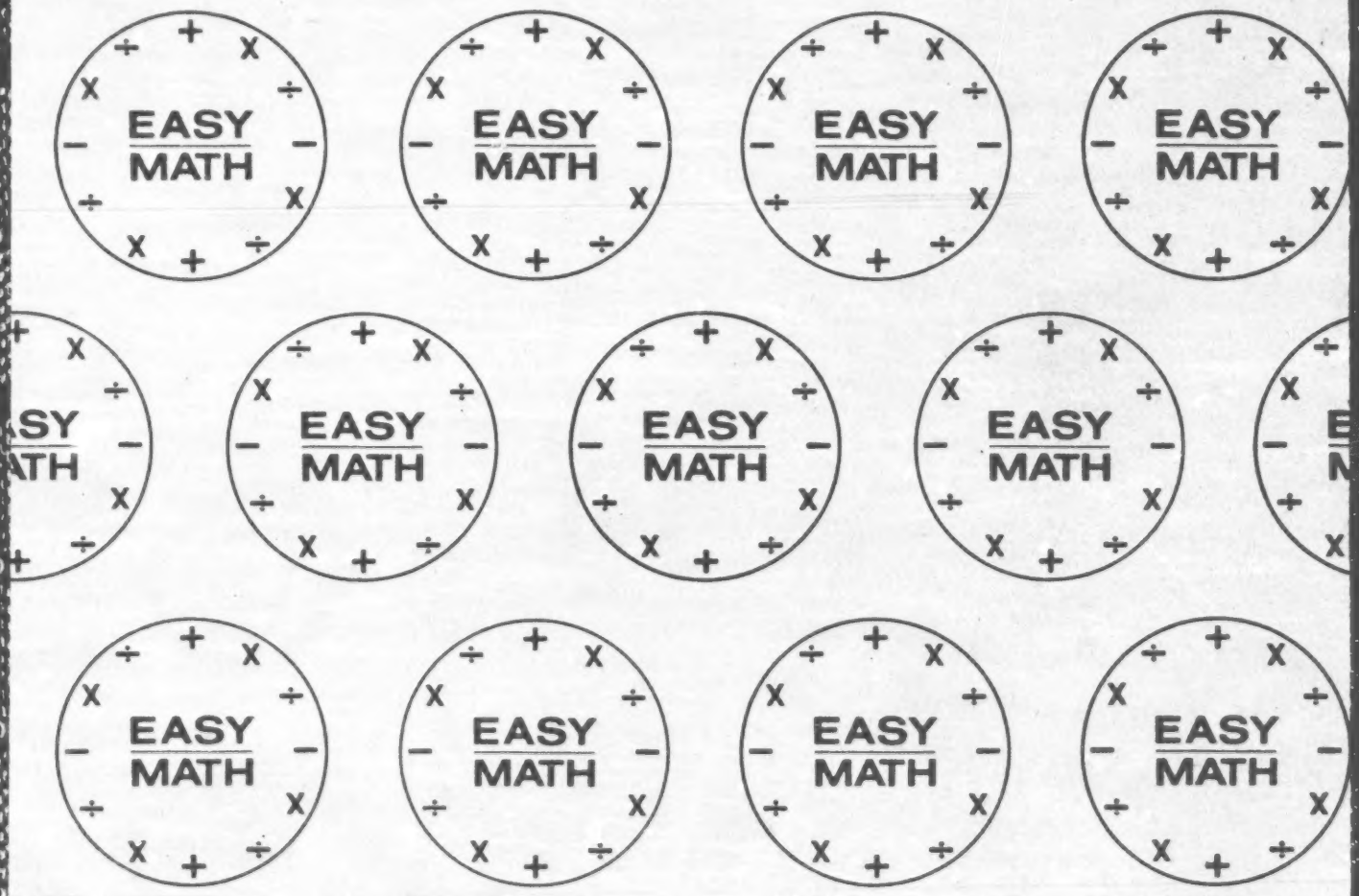
  Activity Book 3: Addition and Subtraction (Tens and Units)

  Activity Book 4: Multiplication and Division

  Activity Book 5: Money

  Activity Book 6: Time

  Activity Book 7: Equivalents and Fractions



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